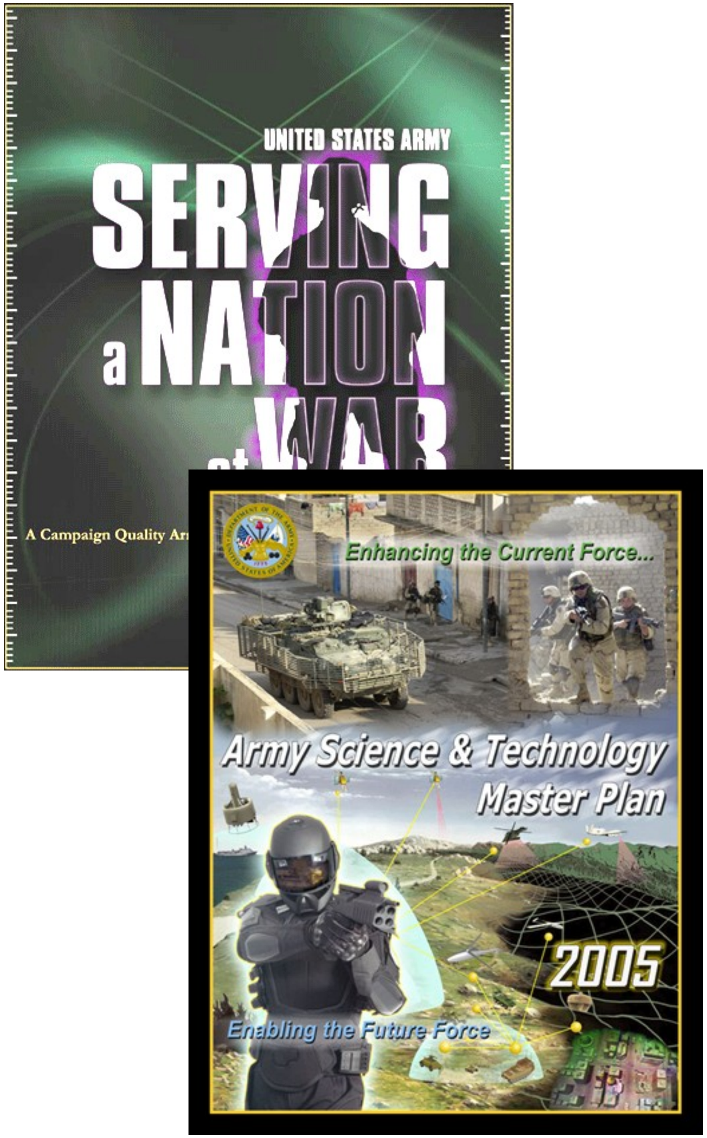
Focus of the Army Science & Technology Program

DoD Technology Exposition

21 April 2005


UNITED STATES ARMY
SERVING a NATION at WAR
A Campaign Quality Ar
Enhancing the Current Force...
Army Science & Technology Master Plan
2005
Enabling the Future Force

Dr. Thomas Killion
Deputy Assistant Secretary
for Research and Technology/
Chief Scientist

Purpose

Describe the focus of the Army’s S&T program

- ***Enabling the Future Force—Future Combat Systems***
- ***Enhancing the Current Force—Force Protection and networks***

Army S&T Vision— Pursuing Transformational Capabilities

Speed, Reach, and Precision

Current Force

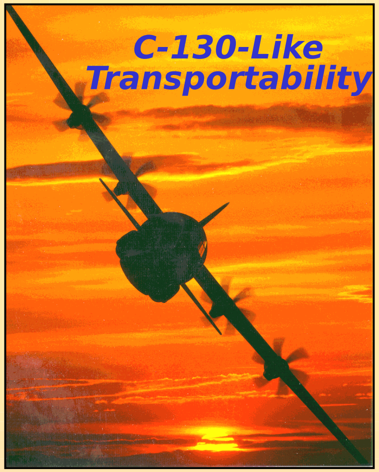
~100 lb. load

70+ tons

< 10 mph

From Platforms to System of Systems

Enabling the Future Force

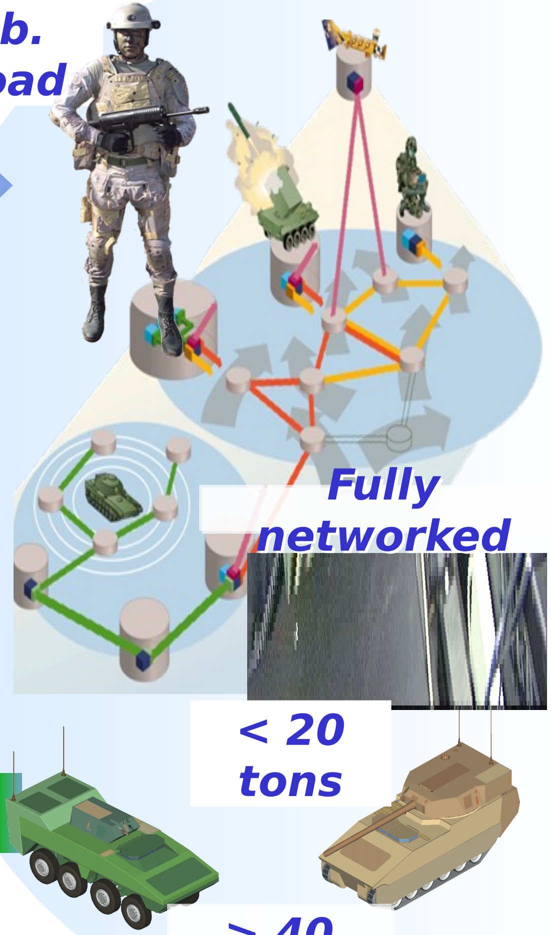


C-130-Like Transportability

Enhancing the Current Force

Future Force

< 40 lb. load

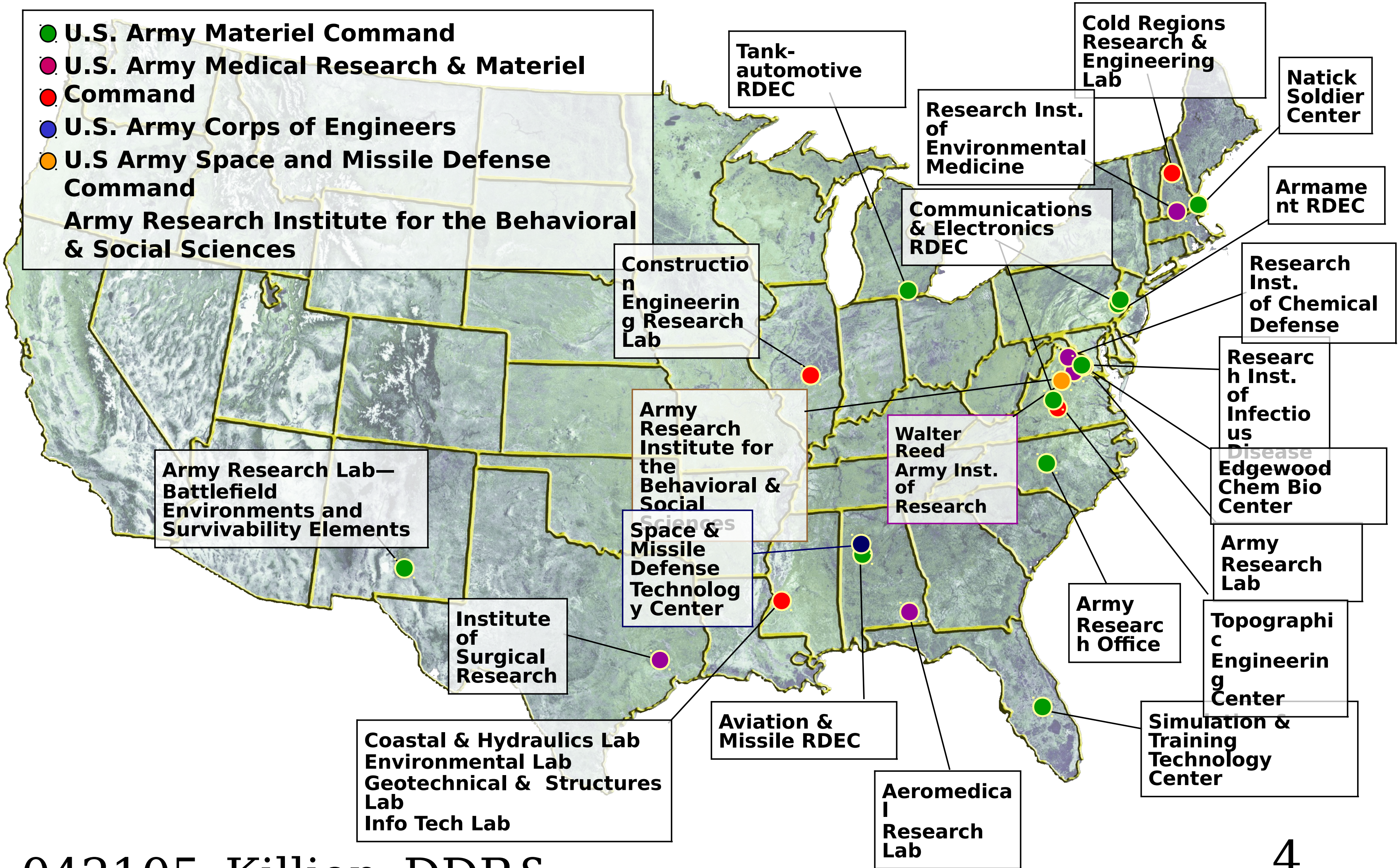


Fully networked

< 20 tons

> 40 mph

Army Research, Development & Engineering Centers and Laboratories



🟢 U.S. Army Materiel Command
🟣 U.S. Army Medical Research & Materiel
🔴 Command
🔵 U.S. Army Corps of Engineers
🟠 U.S Army Space and Missile Defense Command
Army Research Institute for the Behavioral & Social Sciences

Tank-automotive RDEC

Cold Regions Research & Engineering Lab

Natick Soldier Center

Research Inst. of Environmental Medicine

Armament RDEC

Communications & Electronics RDEC

Construction Engineering Research Lab

Research Inst. of Chemical Defense

Research Inst. of Infectious Disease

Army Research Institute for the Behavioral & Social Sciences

Walter Reed Army Inst. of Research

Edgewood Chem Bio Center

Army Research Lab—Battlefield Environments and Survivability Elements

Space & Missile Defense Technology Center

Army Research Lab

Army Research Office

Topographic Engineering Center

Institute of Surgical Research

Simulation & Training Technology Center

Aviation & Missile RDEC

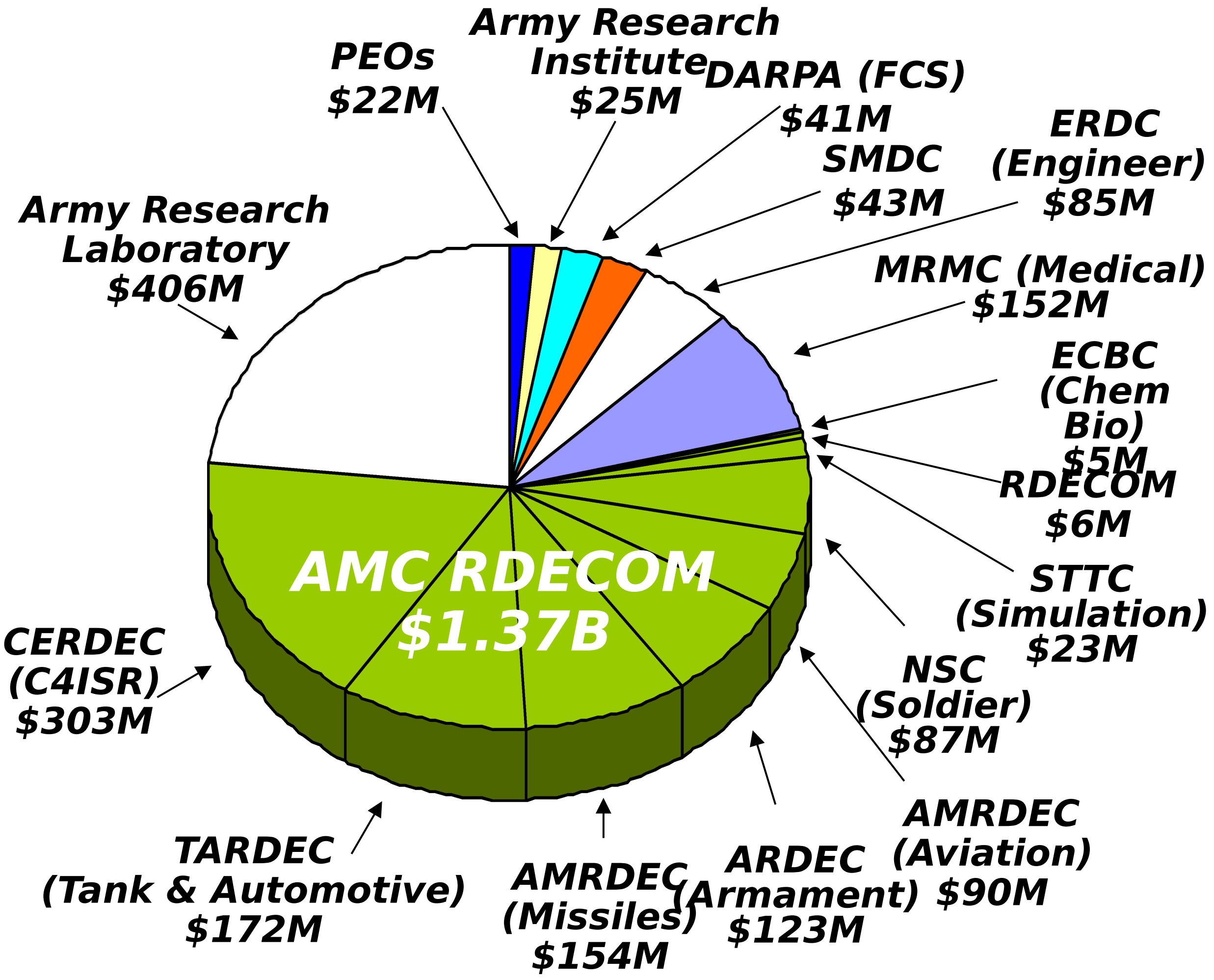
Coastal & Hydraulics Lab
Environmental Lab
Geotechnical & Structures Lab
Info Tech Lab

Aeromedical Research Lab

FY06 Army S&T Investment Perspective

President's Budget

Lab	FY06
Army Research Lab	$406M
CERDEC (C4ISR)	$303M
TARDEC (Tank & Automotive)	$172M
AMRDEC (Missiles)	$154M
MRMC (Medical)	$152M
ARDEC (Armament)	$123M
AMRDEC (Aviation)	$90M
NSC	$87M
ERDC	$85M
SMDC	$43M
DARPA (FCS)	$41M
Army Research Institute	$25M
STTC	$23M
PEOs	$22M
RDECOM	$6M
ECBC	$5M
FY06 S&T Total	**$1.74B**



FY06 Budget Highlights

- ***$308M for basic research to enable paradigm-shifting capabilities to ensure future land component dominance in Joint Force Operations. Key investment areas include nanoscience, biotechnology and immersive simulations.***

- ***$292M for C4ISR technologies that enable networked surveillance and knowledge systems for decisive command on-the-move operations.***

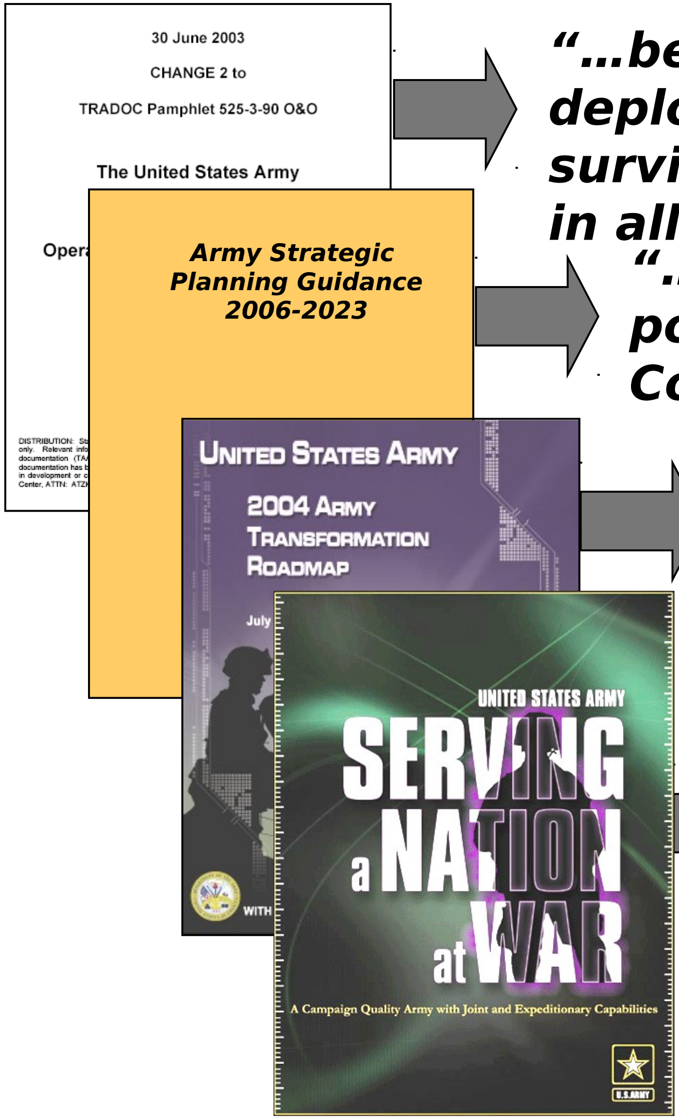
- ***$258M for lightweight precision munition technologies that enable networked lethality to provide high volume, accurate strikes to deny enemy sanctuaries, including directed energy applications.***

- ***$173M force protection technology. Includes funding for counter IED technology and active/passive protection for both ground and air vehicles.***

- ***$87M for high efficiency, lightweight Energy and Power sources for Soldier System and land combat vehicle applications.***

- ***$86M for technologies to enable semi-autonomous and***

Responding to Army Needs



30 June 2003

CHANGE 2 to

TRADOC Pamphlet 525-3-90 O&O

The United States Army

Army Strategic Planning Guidance 2006-2023

UNITED STATES ARMY

2004 ARMY TRANSFORMATION ROADMAP

July

UNITED STATES ARMY

SERVING a NATION at WAR

A Campaign Quality Army with Joint and Expeditionary Capabilities

"…become a more strategically responsive, deployable, agile, versatile, lethal, survivable, and sustainable force, effective in all situations …"

"…provide relevant and ready land power capability to the Combatant Commander as part of the Joint Team"

"…provide dominant land power to the Joint Force now and into the future."

"…change in time of war must deal simultaneously with both current and future needs"

Army S&T Program Drivers— Current and Future Force Capability Gaps

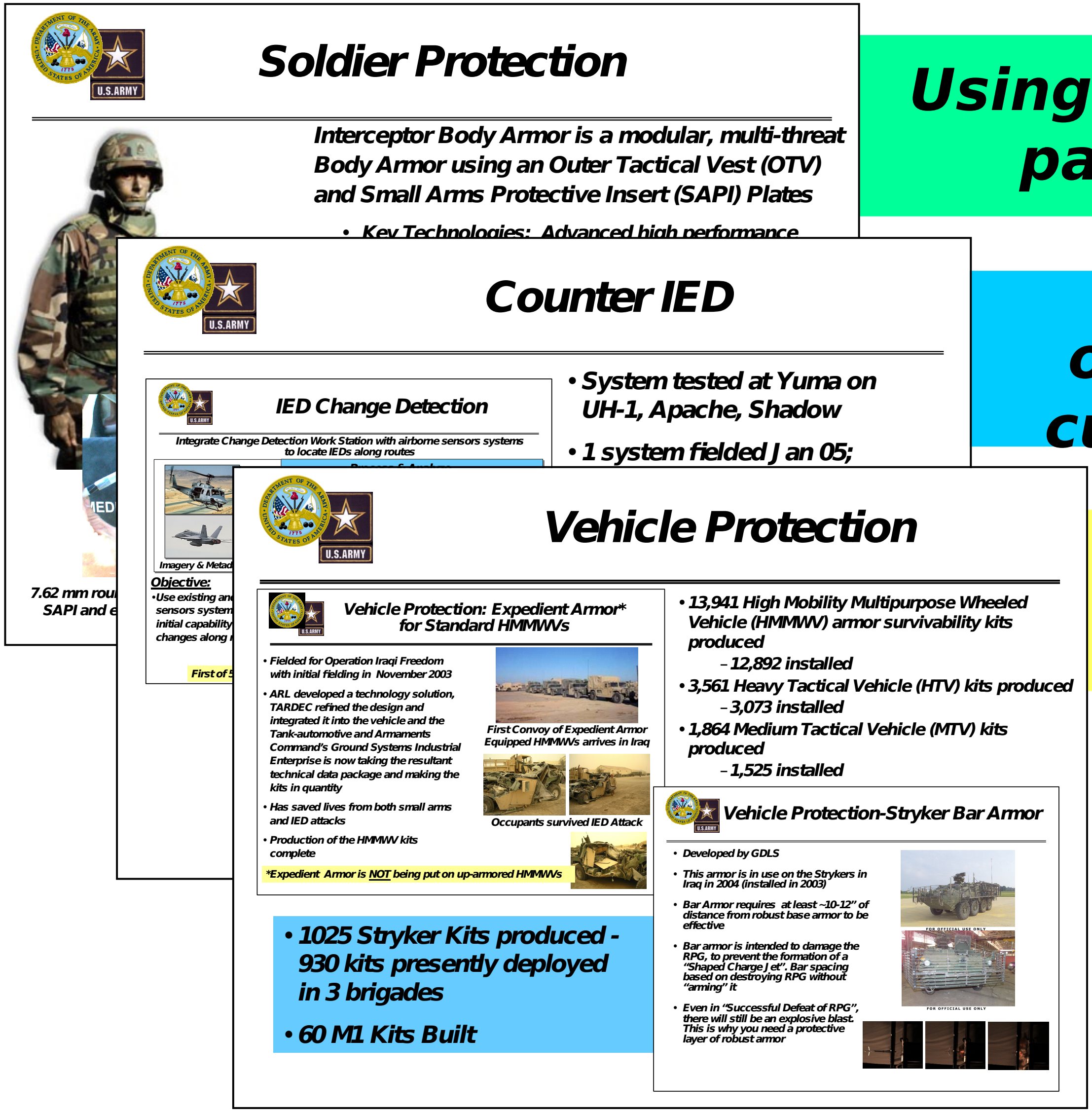
Emerging Top Challenges for Current Force

- ***Improve Soldier Protection in Counter-Insurgency Environment***
- ***Provide Prototype Network Enabled Battle Command to Current Force***
- ***Provide Responsive, Networked, Precision Fire***
- ***Protect the Force in Non-Contiguous Battlespa***
- ***Improve Non-Lethal Capabilities for the Curren***
- ***Improve Ability of Current Forces to Conduct J***
- ***Expand HUMINT Capabilities***
- ***Increase Ability and Speed of Analysis and Inf***
- ***Increase Army Ability for Sustained, High Oper***
- ***Improve SOF and Conventional Forces Integra***

Top Ten Future Required Capabilities from Capabilities Needs Assessment

- ***Enhance Soldier Protection***
- ***Provide Effective C^2 Throughout All Phases of Ops; Any Location***
- ***Enhance Platform Protection***
- ***Provide C^4 Architecture – Fully Functional in all Conditions, LOS/NLOS***
- ***Provide Modular, Tailorable Forces Rapidly Deployable in Mission Config***
- ***Lethality Overmatch – Any Enemy LOS/BLOS/NLOS, All Conditions***
- ***Allow Train as you Fight, Operating Similar at both CTCs & Home Station***
- ***Provide Superior ISR – Modular, Scalable, Tailored Battlefield Awareness***
- ***Provide Enhanced Countermine (CM) Capabilities***
- ***Provide Modular Forces Tailored for Self-Sufficiency and Endurance***

Enhancing the Current Force supporting GWOT



Soldier Protection

Interceptor Body Armor is a modular, multi-threat Body Armor using an Outer Tactical Vest (OTV) and Small Arms Protective Insert (SAPI) Plates

- Key Technologies: Advanced high performance

7.62 mm rou
SAPI and e

Counter IED

IED Change Detection

Integrate Change Detection Work Station with airborne sensors systems to locate IEDs along routes

Process & Analyze

Imagery & Metad

Objective:

- Use existing and
sensors system
initial capability
changes along r

First of 5

- System tested at Yuma on UH-1, Apache, Shadow
- 1 system fielded Jan 05;

Vehicle Protection

Vehicle Protection: Expedient Armor* for Standard HMMWVs

- Fielded for Operation Iraqi Freedom with initial fielding in November 2003
- ARL developed a technology solution, TARDEC refined the design and integrated it into the vehicle and the Tank-automotive and Armaments Command's Ground Systems Industrial Enterprise is now taking the resultant technical data package and making the kits in quantity
- Has saved lives from both small arms and IED attacks
- Production of the HMMWV kits complete

First Convoy of Expedient Armor Equipped HMMWVs arrives in Iraq

Occupants survived IED Attack

*Expedient Armor is NOT being put on up-armored HMMWVs

- 13,941 High Mobility Multipurpose Wheeled Vehicle (HMMWV) armor survivability kits produced
  - 12,892 installed
- 3,561 Heavy Tactical Vehicle (HTV) kits produced
  - 3,073 installed
- 1,864 Medium Tactical Vehicle (MTV) kits produced
  - 1,525 installed

- 1025 Stryker Kits produced - 930 kits presently deployed in 3 brigades
- 60 M1 Kits Built

Vehicle Protection-Stryker Bar Armor

- Developed by GDLS
- This armor is in use on the Strykers in Iraq in 2004 (installed in 2003)
- Bar Armor requires at least ~10-12" of distance from robust base armor to be effective
- Bar armor is intended to damage the RPG, to prevent the formation of a "Shaped Charge Jet". Bar spacing based on destroying RPG without "arming" it
- Even in "Successful Defeat of RPG", there will still be an explosive blast. This is why you need a protective layer of robust armor

FOR OFFICIAL USE ONLY

FOR OFFICIAL USE ONLY

Using technology from past investments

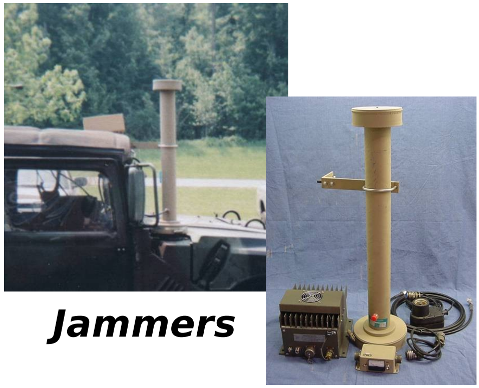
Exploiting opportunities from current investments

Leveraging Scientist & Engineer expertise

> **"We do not want to wait for perfect solutions"**
> **- GEN Abizaid**

S&T Products Fielded through the Rapid Equipping Force

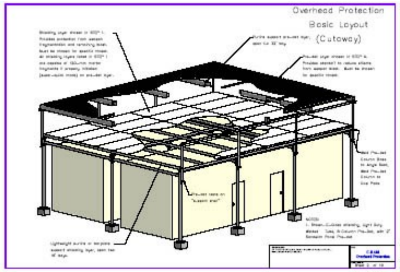
Communications Electronics RDEC



Jammers

Breadcrumb—wireless repeater

Engineer RDC


Overhead Protection
Basic Layout
(Cutaway)

BACKSTOP

DARPA

BOOMERANG

Sandia National Lab

GAUNTLETS

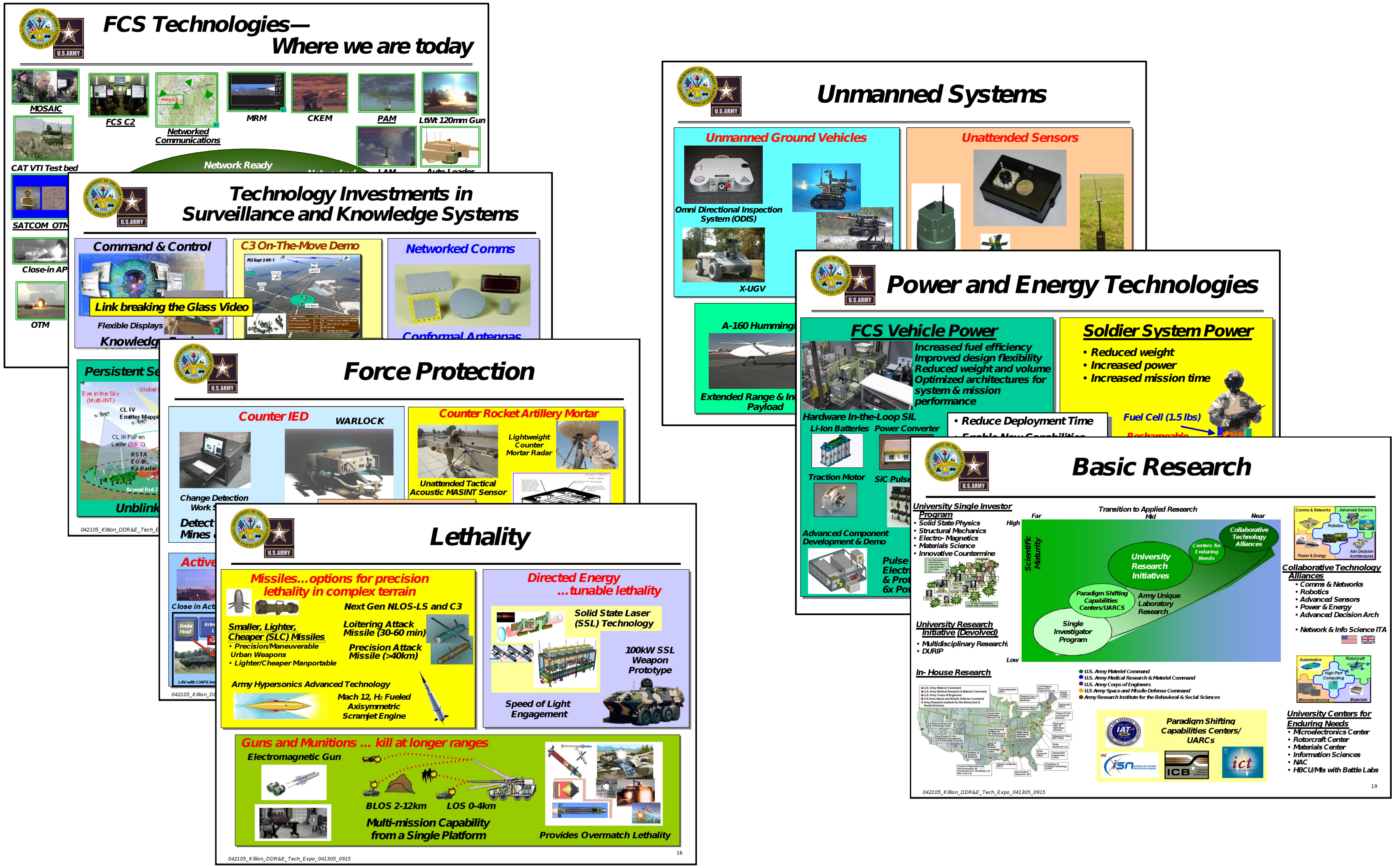
Armaments RDEC

CROWS Lite

Army Research Lab

HUNTER/KILLER

Major S&T Investments



FCS Technologies— Where we are today

MOSAIC
FCS C2
Networked Communications
MRM
CKEM
PAM
LtWt 120mm Gun
CAT VTI Test bed
Network Ready
LAM
Auto Leader
SATCOM OTM
Close-in AP
OTM

Technology Investments in Surveillance and Knowledge Systems

Command & Control

Link breaking the Glass Video

Flexible Displays

Knowledge

C3 On-The-Move Demo

Networked Comms

Conformal Antennas

Persistent Se

Eye in the Sky (Multi-INT)
Global
CL IV Emitter Mapping
CL III FoPen Ladar
RSTA EO IR, Ka Radar
Beyond Red Z

Unblink

042105_Killion_DDR&E_Tech_E

Force Protection

Counter IED

WARLOCK

Change Detection Work S

Detect Mines

Counter Rocket Artillery Mortar

Lightweight Counter Mortar Radar

Unattended Tactical Acoustic MASINT Sensor

Active

Close in Act

Radar Head
LAV with CIAPS Ins

042105_Killion_DD

Lethality

Missiles…options for precision lethality in complex terrain

Next Gen NLOS-LS and C3

Smaller, Lighter, Cheaper (SLC) Missiles
- Precision/Maneuverable Urban Weapons
- Lighter/Cheaper Manportable

Loitering Attack Missile (30-60 min)

Precision Attack Missile (>40km)

Army Hypersonics Advanced Technology

Mach 12, H_2 Fueled Axisymmetric Scramjet Engine

Directed Energy …tunable lethality

Solid State Laser (SSL) Technology

100kW SSL Weapon Prototype

Speed of Light Engagement

Guns and Munitions … kill at longer ranges

Electromagnetic Gun

BLOS 2-12km

LOS 0-4km

Multi-mission Capability from a Single Platform

Provides Overmatch Lethality

042105_Killion_DDR&E_Tech_Expo_041305_0915

16

Unmanned Systems

Unmanned Ground Vehicles

Omni Directional Inspection System (ODIS)

X-UGV

Unattended Sensors

A-160 Hummingb

Extended Range & In Payload

Power and Energy Technologies

FCS Vehicle Power

- Increased fuel efficiency
- Improved design flexibility
- Reduced weight and volume
- Optimized architectures for system & mission performance

Hardware In-the-Loop SIL

Li-Ion Batteries

Power Converter

Traction Motor

SiC Pulse

Advanced Component Development & Demo

Pulse Electr & Prot 6x Pov

Soldier System Power

- Reduced weight
- Increased power
- Increased mission time

Fuel Cell (1.5 lbs)

Rechargeable

- Reduce Deployment Time
- Enable New Capabilities

Basic Research

University Single Investigator Program
- Solid State Physics
- Structural Mechanics
- Electro- Magnetics
- Materials Science
- Innovative Countermine

University Research Initiative (Devolved)
- Multidisciplinary Research
- DURIP

In- House Research

Transition to Applied Research
Far
Mid
Near
High
Low
Scientific Maturity
Collaborative Technology Alliances
Centers for Enduring Needs
University Research Initiatives
Paradigm Shifting Capabilities Centers/UARCS
Army Unique Laboratory Research
Single Investigator Program

- U.S. Army Materiel Command
- U.S. Army Medical Research & Materiel Command
- U.S. Army Corps of Engineers
- U.S. Army Space and Missile Defense Command
- Army Research Institute for the Behavioral & Social Sciences

Paradigm Shifting Capabilities Centers/ UARCs

IAT
ISN
ICB
ict
Comms & Networks
Advanced Sensors
Robotics
Power & Energy
Adv Decision Architectures
Automotive
Rotorcraft
High Perf Computing
Microelectronics
Materials

Collaborative Technology Alliances
- Comms & Networks
- Robotics
- Advanced Sensors
- Power & Energy
- Advanced Decision Arch

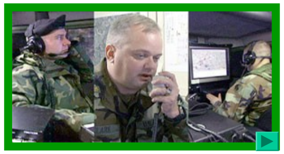
- Network & Info Science ITA

University Centers for Enduring Needs
- Microelectronics Center
- Rotorcraft Center
- Materials Center
- Information Sciences
- NAC
- HBCU/MIs with Battle Labs

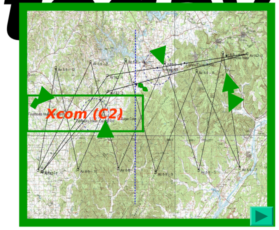
042105_Killion_DDR&E_Tech_Expo_041305_0915

19

FCS Technologies— Where we are today


Multi function OTM Secure Adaptive Integrated Comms

FCS C2



Networked Communications

Mid Range Munition

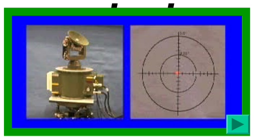
Compact KE Missile

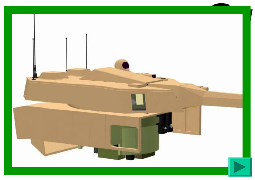
Precision Attack Msl

Seeker Dome Cover Separation
Loiter Attack Msl

CAT VTI Test

LtWt 120mm


SATCOM On The Move


Auto Loader

Network Ready

Networked Lethality

Networked Battle Command

KPP's

Sustainability & Reliability

Survivability

Transportability

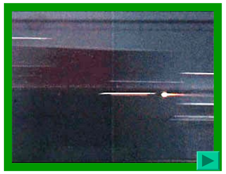
Training

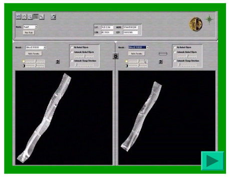
Close-in Active Protection Sys (APS)

Hummingbi

On The Move APS

Adv Armor


KE APS


Change Detection

UGV

Spinner-Mobility

Micro Air Vehicle

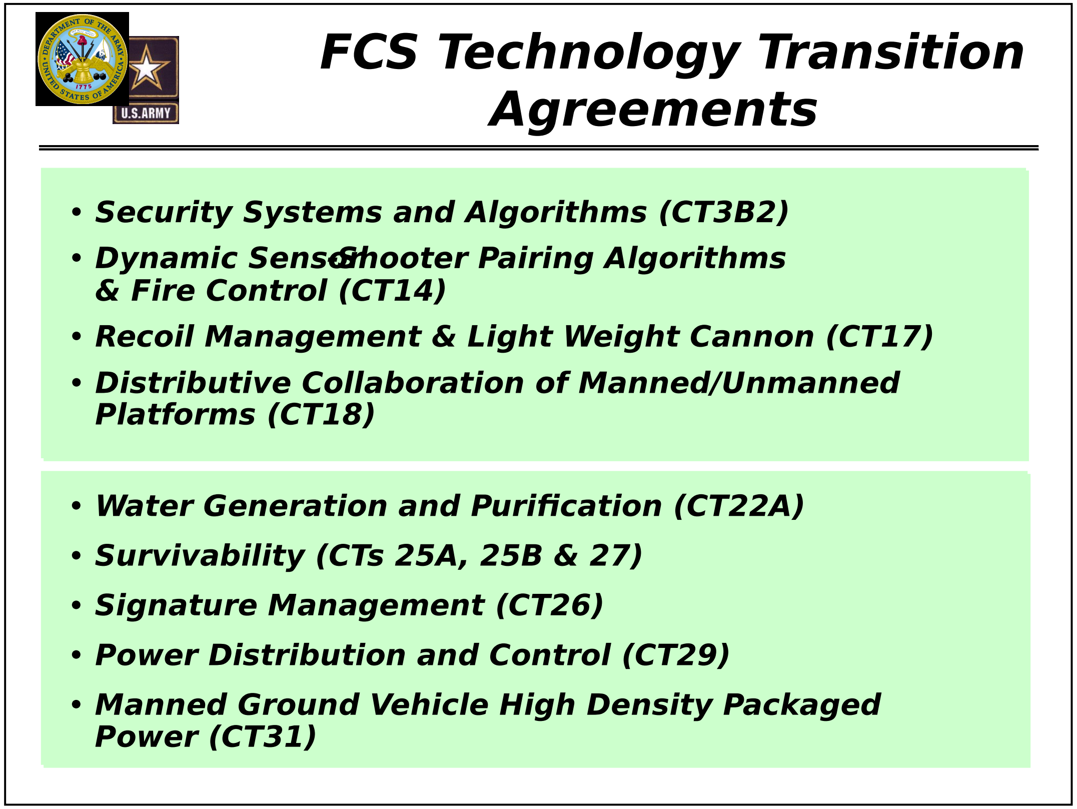
Technologies for the Current & Future Force

Technology Transition Agreements

Documents acquisition program needs for Critical Technologies under development by the S&T community

Key elements:

- ***Program Requirements***
- ***Technology Maturation Plans***
- ***Milestones & Schedule***
- ***Funding***



FCS Technology Transition Agreements

- ***Security Systems and Algorithms (CT3B2)***
- ***Dynamic Sensor-Shooter Pairing Algorithms & Fire Control (CT14)***
- ***Recoil Management & Light Weight Cannon (CT17)***
- ***Distributive Collaboration of Manned/Unmanned Platforms (CT18)***

- ***Water Generation and Purification (CT22A)***
- ***Survivability (CTs 25A, 25B & 27)***
- ***Signature Management (CT26)***
- ***Power Distribution and Control (CT29)***
- ***Manned Ground Vehicle High Density Packaged Power (CT31)***

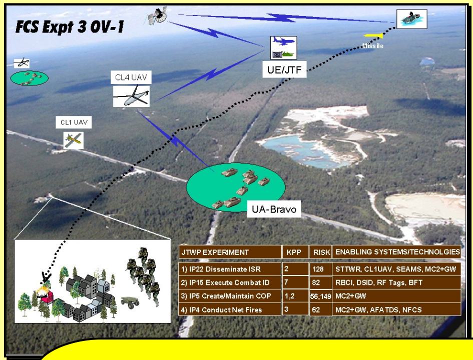
Technology Investments in Surveillance and Knowledge Systems

Command & Knowledge Fusion

Vehicle Technology
Human Research and Engineering
Survivability/Lethality
Computing and Info
Sensors and Electron D
Sensors
Electron Devices
UNIVERSAL DISPLAY CORPORATION

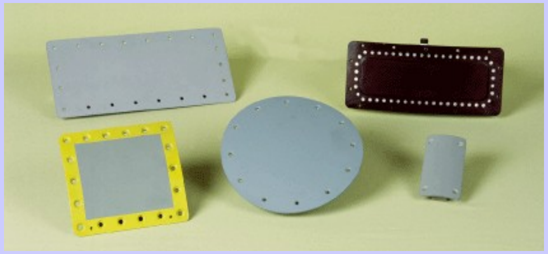
Flexible Displays

C3 On-The-Move Demo


FCS Expt 3 OV-1
UE/JTF
Missile
CL4 UAV
CL1 UAV
UA-Bravo

JTWP EXPERIMENT	KPP	RISK	ENABLING SYSTEMS/TECHNOLGIES
1) IP22 Disseminate ISR	2	128	STTWR, CL1UAV, SEAMS, MC2+GW
2) IP15 Execute Combat ID	7	82	RBCI, DSID, RF Tags, BFT
3) IP5 Create/Maintain COP	1,2	56,149	MC2+GW
4) IP4 Conduct Net Fires	3	62	MC2+GW, AFATDS, NFCS

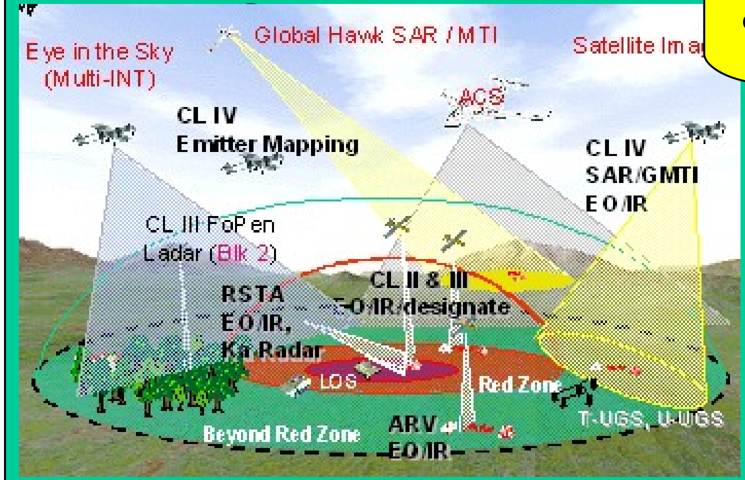
Networked Comms



Conformal Antennas

- **Find the Enemy**
- **Assured Comms**
- **Battle Command**

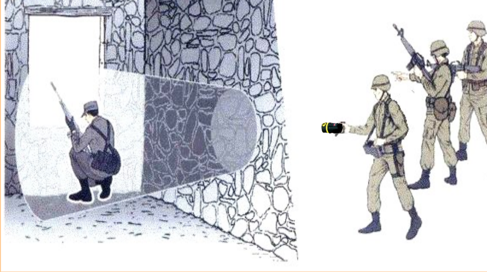
Persistent Sensor


Eye in the Sky
(Multi-INT)
Global Hawk SAR / MTI
Satellite Imag
ACS
CL IV
Emitter Mapping
CL IV
SAR/GMTI
EO/IR
CL III FoPen
Ladar (Blk 2)
CL II & III
EO/IR/designate
RSTA
EO/IR,
Ka Radar
LOS
Red Zone
T-UGS, U-UGS
Beyond Red Zone
ARV
EO/IR

Unblinking "Eye"

Portable SA for the Soldier

Improved MOUT SA



Disposable Sensors

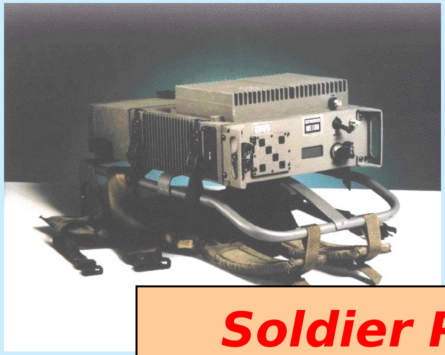
Through Wall Sensing

Force Protection

Counter IED

WARLOCK

Change Detection Work Station

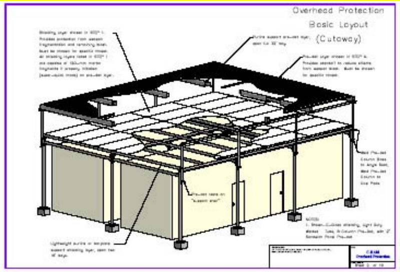


Detect & Neutralize Mines & “Booby Traps”

Counter Rocket Artillery Mortar

Unattended Tactical Acoustic MASINT Sensor

Lightweight Counter Mortar Radar


Overhead Protection
Basic Layout
(Cutaway)

Backstop

Soldier Protection

Deltoid Axillary Protection

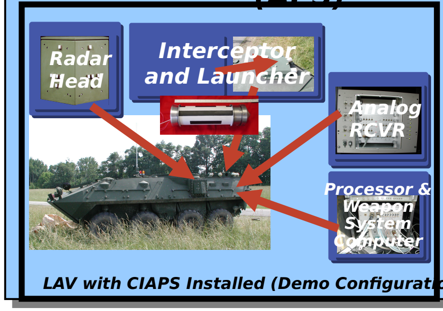
Interceptor

SAPI Plates

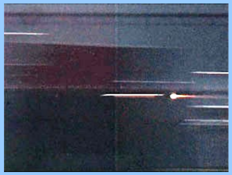
LARGE
STRIKE FACE
HANDLE WITH CARE
TOP
U.S.

Active Protection

Close in Active Protection System (APS)

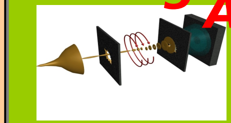

Radar Head
Interceptor and Launcher
Analog RCVR
Processor & Weapon System Computer

LAV with CIAPS Installed (Demo Configuration)



KE APS

Light Weight Arm



Structural, Electromagnetic, and Smart Armors

Lethality

Missiles…options for precision lethality in complex terrain

Next Gen NLOS-LS and C3

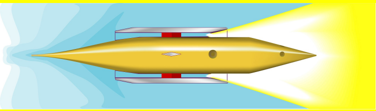
Smaller, Lighter, Cheaper (SLC) Missiles

- **Precision/Maneuverable Urban Weapons**
- **Lighter/Cheaper Manportable**

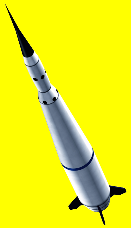
Loitering Attack Missile (30-60 m

Precision Attack Missile (>40km)

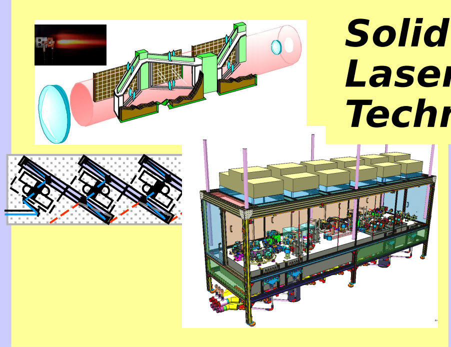
Army Hypersonics Advanced Technology



Mach 12, H_2 Fueled Axisymmetric Scramjet Engine



Directed Energy …tunable lethality



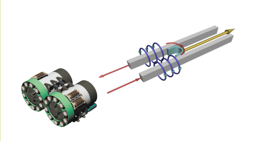
Solid State Laser (SSL) Technology

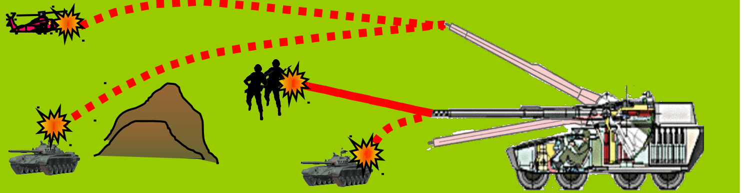
100kW SSL Weapon Prototype

Speed of Light Engagement

Guns and Munitions … kill at longer ranges

Electromagnetic Gun





BLOS 2-12km **LOS 0-4km**

Multi-mission Capability from a Single Platform

Provides Overmatch Lethality

Unmanned Systems

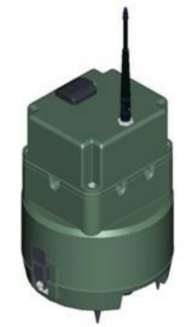
Unmanned Ground

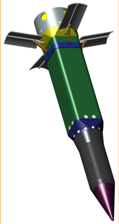
Omni Directional Inspection System (ODIS)

Talon Robot

X-UGV

Unattended Se





Unmanned Air Vehicles

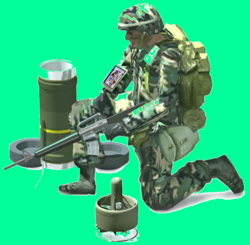
A-160 Hummingbird

Extended Range & Increased Payload

Organic Air Vehicle (OAV)

Extended Range & Endurance

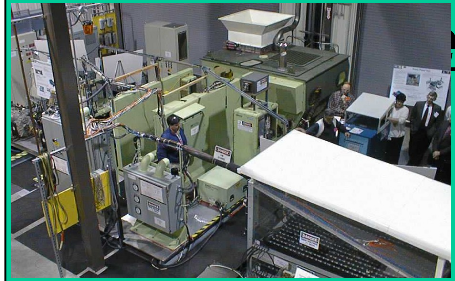
Micro Air Vehicle (MAV)



Extended Loiter "Perch & Stare"

Power and Energy Technologies

FCS Vehicle



Increased fuel efficiency
Improved design flexibility
Reduced weight and volume
Optimized architectures for system & mission perfor

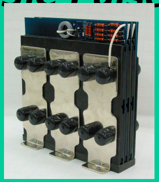
Hardware In-the-Loop SIL

Li-Ion Batteries

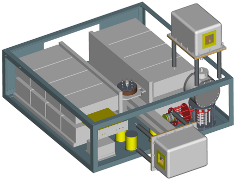
Power Converter

Traction Motor

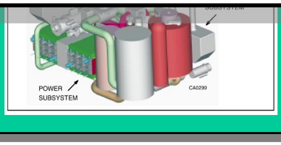
SiC Pulse



Advanced Component Development & Demo



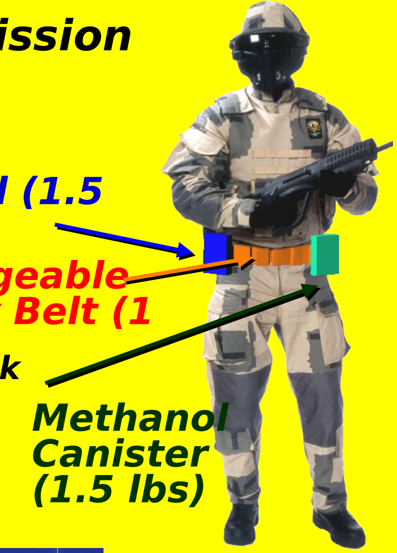
Pulse Power for... Electric Weapons & Protection... 6x Power


POWER SUBSYSTEM
CA0299

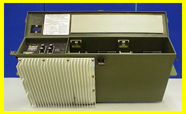
- Reduce Deployment Time
- Enable New Capabilities
  - Lethality
  - Survivability
  - Situational Awareness
- Improve Sustainment
  - Extend Mission Time

Soldier System Power

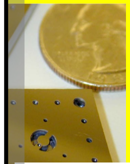
- Reduced weight
- Increased power
- Increased mission time


Fuel Cell (1.5 lbs)
Rechargeable Battery Belt (1 lbs)
Methanol Canister (1.5 lbs)

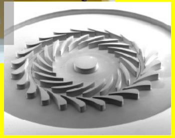
Battery Pack



Rapid Smart Chargers



Microengines

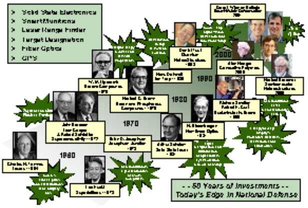


5X-10x Power Density

Basic Research

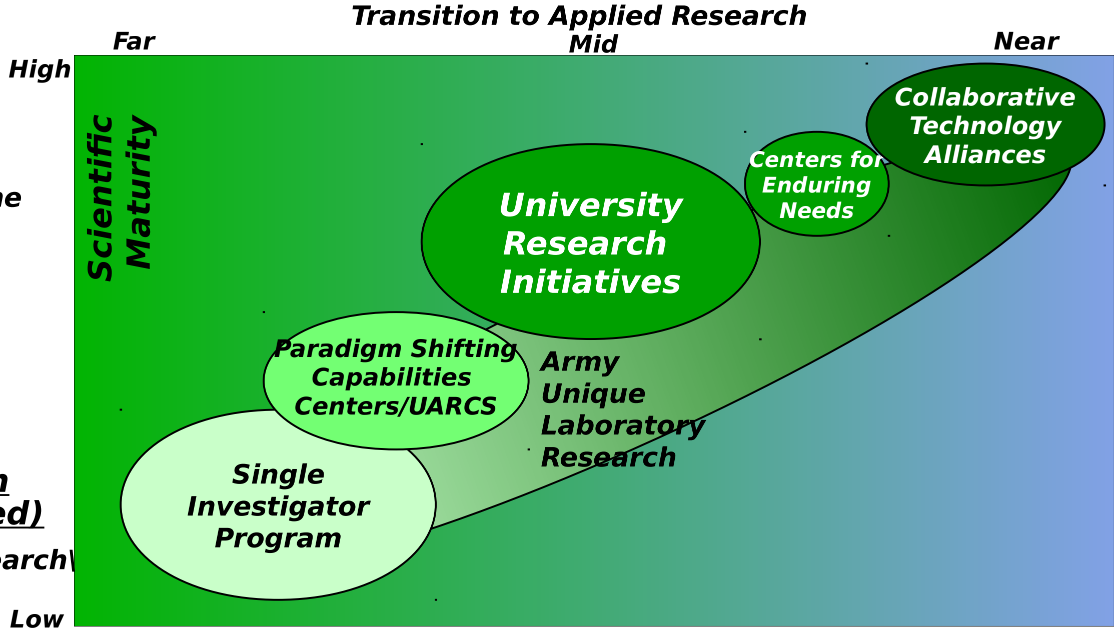
University Single Investor Program

- Solid State Physics
- Structural Mechanics
- Electro- Magnetics
- Materials Science
- Innovative Countermine


Solid State Electronics
Smart Munitions
Laser Range Finder
Target Designation
Fiber Optics
GPS
2000
1990
1980
1970
1960
- - 50 Years of Investments - -
Today's Edge In National Defense

University Research Initiative (Devolved)

- Multidisciplinary Research\
- DURIP


Transition to Applied Research

Far

Mid

Near

High

Low

Scientific Maturity

Collaborative Technology Alliances

Centers for Enduring Needs

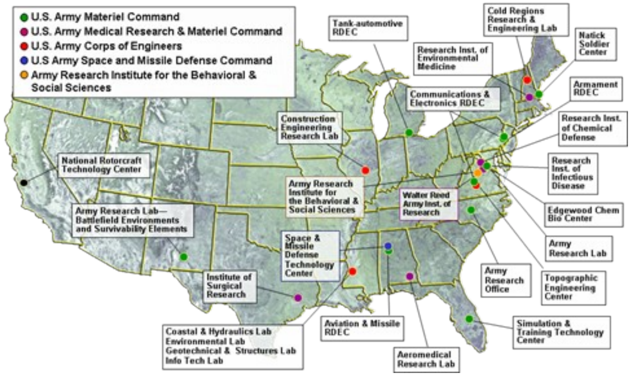
University Research Initiatives

Paradigm Shifting Capabilities Centers/UARCS

Army Unique Laboratory Research

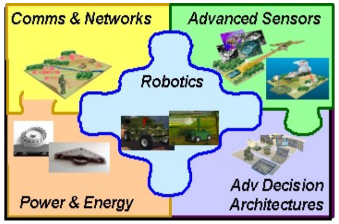
Single Investigator Program

In- House Research


U.S. Army Materiel Command
U.S. Army Medical Research & Materiel Command
U.S. Army Corps of Engineers
U.S Army Space and Missile Defense Command
Army Research Institute for the Behavioral & Social Sciences
Tank-automotive RDEC
Cold Regions Research & Engineering Lab
Natick Soldier Center
Research Inst. of Environmental Medicine
Communications & Electronics RDEC
Armament RDEC
Construction Engineering Research Lab
Research Inst. of Chemical Defense
National Rotorcraft Technology Center
Research Inst. of Infectious Disease
Army Research Institute for the Behavioral & Social Sciences
Walter Reed Army Inst. of Research
Edgewood Chem Bio Center
Army Research Lab—Battlefield Environments and Survivability Elements
Space & Missile Defense Technology Center
Army Research Lab
Army Research Office
Topographic Engineering Center
Institute of Surgical Research
Aviation & Missile RDEC
Simulation & Training Technology Center
Coastal & Hydraulics Lab
Environmental Lab
Geotechnical & Structures Lab
Info Tech Lab
Aeromedical Research Lab

- ● U.S. Army Materiel Command
- ● U.S. Army Medical Research & Materiel Command
- ● U.S. Army Corps of Engineers
- ● U.S Army Space and Missile Defense Command
- ● Army Research Institute for the Behavioral & Social Sciences

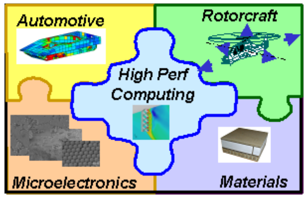
Paradigm Shifting Capabilities Centers/ UARCs


Comms & Networks
Advanced Sensors
Robotics
Power & Energy
Adv Decision Architectures

Collaborative Technolog Alliances

- Comms & Networks
- Robotics
- Advanced Sensors
- Power & Energy
- Advanced Decision Arch

- Network & Info Science ITA

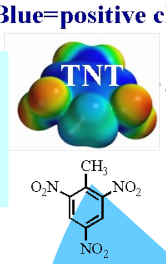

Automotive
Rotorcraft
High Perf Computing
Microelectronics
Materials

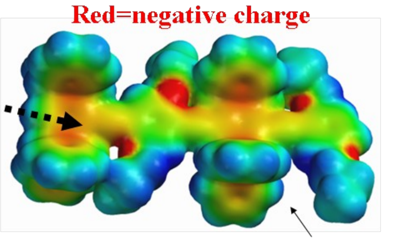
University Centers for Enduring Needs

- Microelectronics Center
- Rotorcraft Center
- Materials Center
- Information Sciences
- NAC
- HBCU/MIs with Battle Labs

GWOT – FIDO’s Contribution

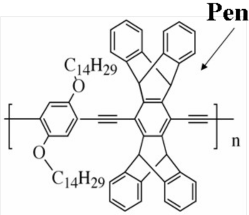
Molecular Engineering

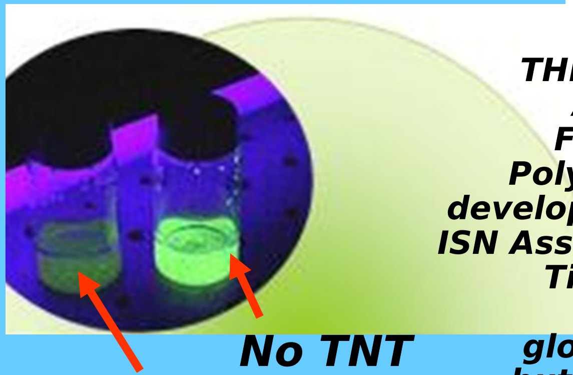

Blue=positive charge
TNT
CH_3
O_2N
NO_2
NO_2


Red=negative charge
Pentiptycene

Design Attributes:

- Highly selective to only TNT and DNT
- Highly resistant to contamination
- Long-term stability for reuse

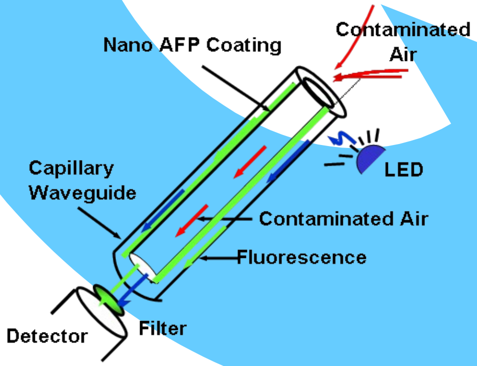

$C_{14}H_{29}$
O
O
$C_{14}H_{29}$
n


No TNT
TNT Detected

THE SCIENCE: Amplifying Fluorescent Polymer (AFP) developed by MIT ISN Associate Dir. Tim Swager normally glows green, but quenches when TNT is present.

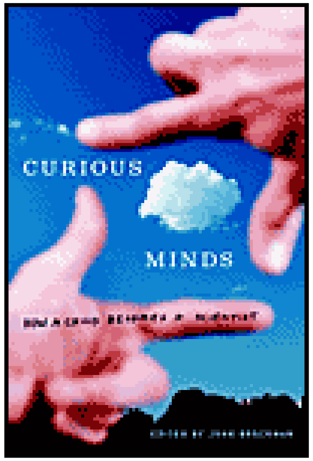
- Rugged
- Handheld
- Lightweight
- Easy to operate
- Audio and visual indications

Integrated Detector/Sampler


Nano AFP Coating
Contaminated Air
LED
Capillary Waveguide
Contaminated Air
Fluorescence
Detector
Filter

FIDO Units in Iraq for Evaluation (Aug 04) – Dragon Runner & Handheld

Creating the Future: Curiosity & Imagination



“I was born to be a theoretical physicist.” Paul Davies

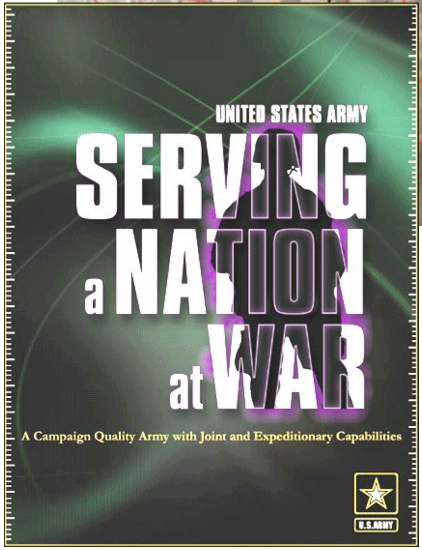
“This, then, was the religion I was raised in: veneration for human creativity and the power of ideas.” Ray Kurzweil

“What has mattered most was doing something creative and lasting.” Lee Smolin

“How did I wind up as a scientist? By all logic, I should start with Gilligan’s Island, a sitcom that entranced me when I was an eight-year-old growing up in Brooklyn.” Robert Sapolsky

“Every great advance in science has issued from a new audacity of imagination.” John Dewey

The Army…
Transforming while at War

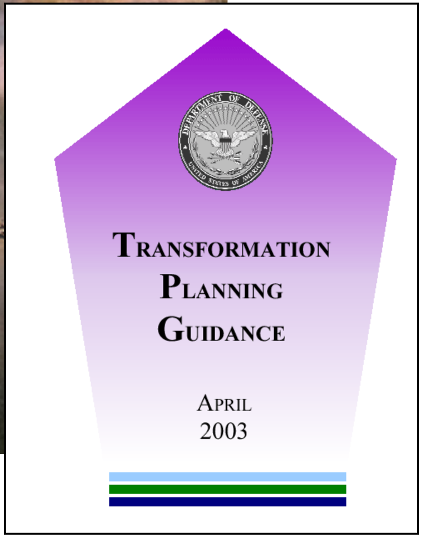


UNITED STATES ARMY

SERVING a NATION at WAR

A Campaign Quality Army with Joint and Expeditionary Capabilities

U.S.ARMY



TRANSFORMATION
PLANNING
GUIDANCE

APRIL
2003

"…this may mean making the difficult decision of foregoing currently planned systems and investing instead in capabilities that we believe will reduce future risk."

Secretary Rumsfeld

"Finally, the nature of expeditionary operations argues for leveraging every potential tool of speed, operational reach, and precision."